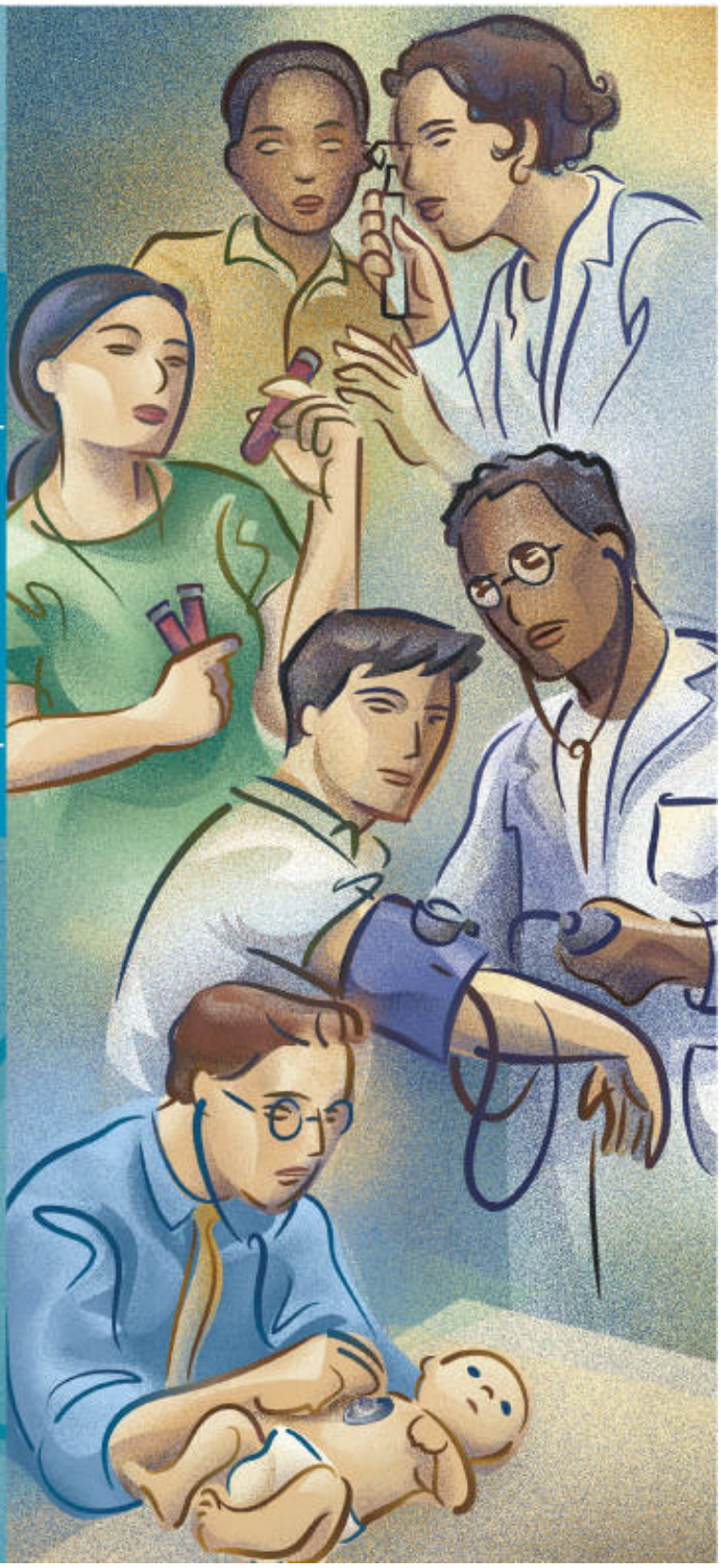
AHRQ

AHRQ QUALITY INDICATORS

Prevention Quality Indicators

SOFTWARE DOCUMENTATION



AHRQ Quality Indicators

Prevention Quality Indicators: Software Documentation, Version 2.1 – SPSS

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Abstract

The value of information on health care quality has never been so widely recognized; yet many organizations lack the resources and/or expertise to build a quality information program from the ground up. Recognizing this, the AHRQ Quality Indicators were developed specifically to meet the short-term needs for information on health care quality using standardized, user-friendly methods and existing sources of data.

This module of the AHRQ Quality Indicators was designed to capitalize on the availability of administrative data on inpatient stays to produce information about 16 Prevention Quality Indicators (PQIs): avoidable *hospitalizations and ambulatory care sensitive condition* (ACSC) indicators, which involve admissions that evidence suggest could have been avoided, at least in part, through better access to high-quality outpatient care.

This document is the software documentation for the Prevention Quality Indicators software Version 2.1, which is provided on the AHRQ Web site. The software was developed in SPSS, for use on a personal computer. By making this tool available, we hope to assist others in producing information on health care quality more cost effectively.

Details on the development of the Prevention Quality Indicators can be found in "Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions."

Acknowledgments

This product is based on the work of many individuals who contributed to its development and testing.

The following staff from the **Evidence-based Practice Center (EPC) at UCSF-Stanford** performed the evidence review, completed the empirical evaluation, and created the programming code and technical documentation for the new Quality Indicators:

Core Project Team
Mark McClellan, M.D., Ph.D., *principal investigator*
Kathryn M. McDonald, M.M., *EPC coordinator*
Sheryl M. Davies, M.A.
Jeffrey Geppert, J.D.
Patrick Romano, M.D., M.P.H.
Kaveh G. Shojania, M.D.

Other Contributors
Amber Barnato, M.D.
Paul Collins, B.A.
Bradford Duncan M.D.
Michael Gould, M.D., M.S.
Paul Heidenreich, M.D.
Corinna Haberland, M.D.
Paul Matz, M.D.
Courtney Maclean, B.A.
Susana Martins, M.D.
Kristine McCoy, M.P.H.
Suzanne Olson, M.A.
L. LaShawndra Pace, B.A.
Mark Schleinitz, M.D.
Herb Szeto, M.D.
Carol Vorhaus, M.B.A
Peter Weiss, M.D.
Meghan Wheat, B.A.

Consultants
Douglas Staiger, Ph.D.

The following staff from **Social & Scientific Systems, Inc.**, developed this software product, documentation, and guide:

Programmers
Leif Karell
Kathy McMillan
Fred Rohde

Technical Writer
Patricia Caldwell
Graphics Designer
Laura Spofford

Contributors from the **Agency for Healthcare Research and Quality**:
Anne Elixhauser, Ph.D.
H. Joanna Jiang, Ph.D.
Margaret Coopey, R.N., M.G.A, M.P.S.

We also wish to acknowledge the contribution of the peer reviewers of the evidence report and the beta-testers of the software products, whose input was invaluable.

Table of Contents

List of Tables

AHRQ Quality Indicators, Software Documentation, Version 2.1: Prevention Quality Indicators

Introduction

This documentation describes the software for implementing the Prevention Quality Indicator (PQI) module of the AHRQ Quality Indicators Version 2.1 and highlights features of the analytic approach of particular interest to new users. Detailed information about the Prevention Quality Indicators (PQI) is contained in the companion document *"Guide to the Prevention Quality Indicators,"* which includes information about the development of the indicators and their definitions.

The software consists of a series of computer programs that:

- Assign and calculate PQIs from hospital discharge abstracts or UB (uniform billing) claims data.
- Print PQI results in SPSS format that can be imported into word processing documents, spreadsheets, or graphics software, at the user's option.
- Create risk-adjusted rates that adjust for casemix differences.
- Create smoothed rates that reduce fluctuations over time due to random variation.

This documentation includes:

- A discussion of the data elements necessary to produce the AHRQ PQIs and the uniform coding conventions recommended for those elements.
- Descriptions of the PQI processing steps in nontechnical language.
- Detailed descriptions of the functions of each PQI SPSS program.

Components of the Prevention Quality Indicators module

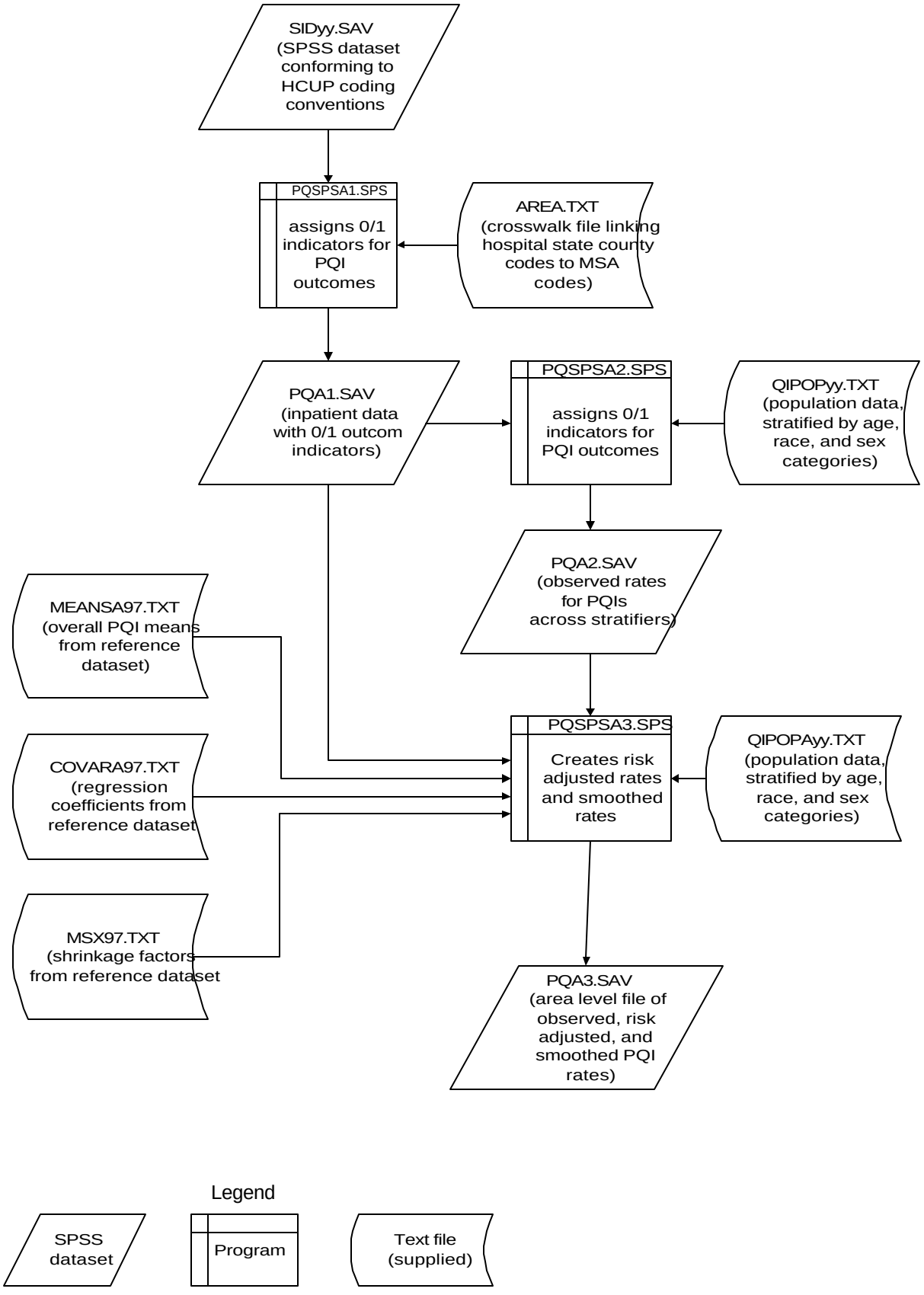
As shown in Table 3 on page 4, the Prevention Quality Indicators module consists of three SPSS programs and ten ASCII text files that contain auxiliary data. These programs and text files are described in the subsequent sections of this document. The programs were developed for use in SPSS, version 7.5 or higher, on an IBM compatible computer.

A note on the naming conventions for the Prevention Quality Indicators (PQI) module programs. The programs have names of the form PQSPSAi.SPS. The first two characters "PQ" of the program name indicates a Prevention Quality Indicators program, to distinguish it from other modules that are forthcoming from AHRQ. The next three characters of the program name are "SPS" and are present to distinguish the program from the SAS versions of the software. The sixth character of the program name is always "A" to denote a program that is for the production of Area indicator rates that use county and Metropolitan Statistical Area (MSA) area populations as denominators. Future modules will generate indicators that use as denominators subsets of the hospitalized population. The last character (i) designates the number of the specific program.

Quick Reference

The subsequent two pages are intended to serve as a quick reference to assist in reading this documentation and in reviewing the Prevention Quality Indicator (PQI) module outputs. Processing steps (Figure 1) are shown first followed by a listing of the module variables (Table 1), variable prefixes (Table 2), and module contents (Table 3). One suggestion is to print these two pages in duplex mode on one sheet of paper that can then be easily referred to as the need arises.

Figure 1. Processing Steps



Prevention Quality Indicator Module Details

Table 1. Prevention Quality Indicator (PQI) Variables

Indicator number	Numerator (admissions for ACSC)	Denominator	Age categories			
			0 to 17	18 to 39	40 to 64	65 +
1	Diabetes short term cx	Area population		Included	Included	Included
2	Perforated appendix	**Appendicitis***	Included	Included	Included	Included
3	Diabetes long term cx	Area population		Included	Included	Included
4	Pediatric asthma	Area population	Included			
5	COPD	Area population		Included	Included	Included
6	Pediatric gastroenteritis	Area population	Included			
7	Hypertension	Area population		Included	Included	Included
8	CHF	Area population		Included	Included	Included
9	Low birth weight	**Births***	NA	NA	NA	NA
10	Dehydration	Area population	Included	Included	Included	Included
11	Bacterial pneumonia	Area population	Included	Included	Included	Included
12	Urinary infection	Area population	Included	Included	Included	Included
13	Angina w/o procedure	Area population		Included	Included	Included
14	Diabetes uncontrolled	Area population		Included	Included	Included
15	Adult asthma	Area population		Included	Included	Included
16	Lower extremity amputation, DM	Area population		Included	Included	Included

ACSC – Ambulatory Care Sensitive Condition.

* The denominator includes all hospital admissions for this condition in the area.

Table 2. Prefixes for the Prevention Quality Indicator (PQI) Variables

Prefix	Contents	Example (for PQI # 1, Diabetes short–term complications)
T	Inpatient numerator (top)	TAPQ01
P	Population denominator (pop)	PAPQ01
O	Observed Rate	OAPQ01
R	Risk-adjusted Rate	RAPQ01
S	Smoothed Rate	SAPQ01

Table 3. Prevention Quality Module Contents

SPSS programs (syntax files)	ASCII text files (data) †
PQSPSA1.SPS	QIPOP97.TXT
PQSPSA2.SPS	QIPOP98.TXT
PQSPSA3.SPS	QIPOP99.TXT
	AREA.TXT
	QIPOP**A**97.TXT
	QIPOP**A**98.TXT
	QIPOP**A**99.TXT
	MEANSA97.TXT
	COVARA97.TXT
	MSX97.TXT

† The ASCII text files are provided with the Prevention Quality module, and are necessary for the programs to run.

Background

The PQI module contains 16 indicators that measure hospital admissions for ambulatory care sensitive conditions (ACSC) across geographic areas. ACSCs represent conditions for which hospitalization could be avoided if the patient receives timely and adequate outpatient care. Many factors influence the quality of outpatient care, including access to care and adequately prescribed treatments, once care is obtained. In addition, patient compliance with those treatments and other patient factors may play a role. In general, areas with lower social-economic status tend to have higher admission rates for ACSCs than areas with higher social-economic status. As with utilization indicators, there are no "right rates" of admission for these conditions. Very low rates could signal inappropriate underutilization of healthcare resources while very high rates could indicate potential overuse of inpatient care.

Therefore, hospital admission for ACSCs is not a measure of hospital quality but a potential indicator of outpatient and community health care need. For example, if an area has a relatively high hospital admission rate for diabetes complications, the local healthcare providers should work with the community to identify reasons and strategies to address the problem.

The 16 ACSCs in the PQI module are listed in Table 1 on page 4. See Appendix A of the "*Guide to the Prevention Quality Indicators"* for the definition of each indicator.

Except for perforated appendix and low birth weight, each indicator is measured as the number of hospital admissions for a particular ACSC per 100,000 residential population in an area. Geographic areas are defined at the MSA (Metropolitan Statistical Area) level for urban areas and at the county level for rural areas. MSAs are defined in terms of entire counties, which include the county (or counties) that contains the largest city and any adjacent counties that have at least 50 percent of their population in the urbanized area surrounding the largest city. In New England, the MSAs are defined in terms of cities and towns rather than counties. The MSA definitions in this software are based on the standards effective June 30, 1999.

The data required for measuring these indicators come from hospital discharge abstracts or billing claims (administrative data) which are readily available in many states. The residential population data are from the Bureau of Census.

The software generates observed, risk-adjusted, and smoothed rates for each indicator at the area level. Observed rates are the raw rates. Risk-adjusted rates are derived from applying the average casemix of a baseline file that reflects a large proportion of the U.S. population to the areas' observed rates. Smoothed rates are estimates with removal of fluctuations over time due to random variation.

For information about how these indicators were identified, see the "*Guide to the Prevention Quality Indicators."*

Data elements and coding conventions

Input for the AHRQ Quality Indicators

The PQI software was written to process data from discharge data abstracts that contain information about hospital stays. The specific data elements that are needed for the PQI software are listed in Table 4. The PQI module was tested on data from the Healthcare Cost and Utilization Project (HCUP). HCUP is an ongoing Federal-State-private collaboration to build uniform databases from administrative hospital-based data collected by State data organizations and hospital associations.

The input data files for the Prevention Quality Indicators software must be in SPSS.

For ease of use, the input data file should contain a specific set of variables coded in specific ways. For example, the PQI software expects a numeric data element named SEX with values coded 1 for male and 2 for female.

We recommend that users recode data elements in their input files to be consistent with the coding expected by the software. This will minimize the number of internal changes that will be necessary in the Prevention Quality Indicators software.

For example, recoding the SEX data element in the input file to be consistent with the coding described above is easier than modifying all uses of the SEX data element in the PQI programs.

Input data elements, their characteristics, and values expected by the software are described in Table 4. Not every value for every data element is referenced by the PQI software. For example, admission source (ASOURCE) values are used only to identify transfers. However, we include the complete set of HCUP values to assist users of the uniform HCUP data files.

To minimize internal changes to the software, all required elements should be present in the input data file. If a required element is not available, a dummy element should be provided. Failure to provide a dummy element will result in errors during the execution of the PQI programs.

Table 4. Data Elements and Coding Conventions

Variable name	Description	Format	Value description	Comments
AGE	Age in years at admission	Numeric	Age in years	
RACE	Race of patient.	Numeric 1 2 3 4 5 6	 White Black Hispanic Asian or Pacific Island Native American other	
SEX	Sex of patient	Numeric 1 2	 Male Female	
HOSPSTCO	Hospital location (FIPS† State/county code)	Numeric ssccc	Modified Federal Information Processing Standards State/county code	Available at: http://www.census.gov/population/estimates/fips.txt
ASOURCE	Admission Source	Numeric 1 2 3 4 5	 ER Another hospital Another fac. incl. LTC court/law enforcement routine/birth/other	
DISP	Disposition of patient	Numeric 1 2 3 4 5 6 7 20	 Routine Short-term hospital Skilled nursing facility Intermediate care Another type of facility Home health care Against medical advice Died	
DRG	Diagnosis Related Group	Numeric	DRG from federal DRG Grouper	
MDC	Major Diagnostic Category	Numeric	MDC from federal DRG grouper	
DX1 – DXn	Diagnoses ICD-9-CM codes. DX1 is the principal diagnosis, DX2-DXn are secondary diagnoses.	String, 5 character	Diagnoses code	Users must specify the number of diagnoses variables as a parameter to the PQSPSA1.SPS program.
NDX	Number of diagnoses (Dx) on the discharge record	Numeric		If the 1st discharge record has 5 Dx and the 2nd has 10, NDX would be 5 on the 1st record and 10 on the second.
PR1 – PRn	Procedure ICD-9-CM codes. PR1 is the principal diagnosis, PR2-PRn are secondary procedures.	String, 4 character	Procedure code	Users must specify the number of procedure variables as a parameter to the PQSPSA1.SPS program.
NPR	Number of procedures (Pr) on the discharge record	Numeric		If the 1st discharge record has 1 Pr and the 2nd has 2, NPR would be 1 on the 1st record and 2 on the 2nd.

†Federal Information Processing Standard, as defined by the U.S. Department of Commerce, National Institute of Standards and Technology (formerly National Bureau of Standards).

Coding of diagnoses, procedures, and DRGs

- *Diagnoses and procedures must be coded using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)*

- *Significant modifications to ICD-9-CM codes occurred in the early 1990s. PQI definitions only reflect codes valid after October 1, 1994, and therefore may not accurately analyze data collected before 1994.*

- Diagnoses and procedure codes should be in character strings.

- Diagnosis and procedure codes should not contain any decimal points.

- Diagnosis and procedure codes should be left justified. Diagnosis codes with fewer than five digits should be padded with spaces (not zeros) on the right. Procedure codes with fewer than four digits should be padded with spaces (not zeros) on the right.

- This software has ICD-9-CM codes updated through FY2001 changes.

- Diagnosis-related groups (DRGs) are those derived from the Centers for Medicare & Medicaid Services (previously Health Care Financing Administration) Medicare grouper. The software expects that you will be using the DRG effective on the discharge date. The software now refers to data elements DRG and MDC. Your data should be coded accordingly. The software may be modified at the user's option to use other types of DRGs. However, the impact of using other types of DRGs should be evaluated carefully before making such a change.

- *Version 2.1 of the software accounts for ICD-9-CM and DRG coding effective through September 30, 2001*.

Missing values

- *The PQI programs do not distinguish among different types of missing values.*

Data files of hospital discharge abstract data may have numeric data elements coded using special missing values. For example, besides the standard SPSS value of "." for system missing data, there might also be present user-defined missing values such as -9 for invalid data, -8 for data unavailable from a particular source, -7 for inconsistent data. However, the PQI programs do **not** distinguish among the different types of missing codes. Therefore, all types of missing values in the input data to the PQI module can be represented by a single system-missing value (.) for numeric variables and a blank (' ') for alphanumeric (or character) variables.

User options

The PQI software reflects the development and implementation of the software in data available to AHRQ. Our goal was to develop the tools, illustrate their use, and then encourage others to adopt and use the tools for their own applications. As a result, we expect and encourage users of the software to consider whether and how to modify the PQI software to better serve their local conditions or interests.

Modifications to the definitions of outcomes of interest or populations at risk are possible but not desirable. Maintaining consistent definitions is important. Once definitions are altered, the ability to make comparisons of PQIs based on original definitions is lost. We encourage users to identify ways to improve the PQI methodology and to share their suggestions with us for future updates.

AHRQ will provide national estimates using the PQIs through its web-based query system, HCUPnet (http://hcup.ahrq.gov/HCUPnet.asp). If users change definitions of the PQIs, it will not be possible to compare users' results to the national estimates in HCUPnet.

Processing steps

Each Prevention Quality Indicator (PQI) expressed as a rate, is simply defined as:

Outcome of interest / Population at risk.

Conceptually, five steps are necessary to produce the PQI rates. The following describes the steps and how the software performs them.

1. Identify outcomes in inpatient records

Inpatient records are marked to indicate whether they contain the outcome of interest (numerator or "top") for each of the AHRQ PQI measures.

This is done by setting a series of flag variables, each of which corresponds to the numerator for a particular PQI. For example, if the inpatient record meets the conditions for inclusion in the outcome for PQI #1, then the outcome indicator for PQI #1 is set to 1.

This step requires one pass through the discharge-level data and outputs a discharge-level data file containing the original input variables and the flag indicator variables for the outcomes for each PQI.

2. Identify populations at risk from Census population data

The populations at risk (the denominators for calculating the PQI rates) are derived from Census population figures.

3. Calculate observed (raw) Prevention Quality Indicator rates

Using the output data from step 1 and Census population data from step 2, the PQI rates are calculated and saved for stratifiers which include area and all two-, three- and four-way interactions between area and age, race and sex.

The programs calculate PQI rates regardless of the number of cases available. However, rates based on only a few cases should be interpreted with caution.

In work at AHRQ, we do not report rates based on fewer than 30 cases in the numerator or the denominator. This exclusion rule serves two purposes:

- It eliminates unstable estimates based on too few cases.
- It helps protect the identities of hospitals and patients.

4. Risk adjust the Prevention Quality Indicator rates.

Overall file means and regression coefficients from a baseline database (reflecting a large proportion of the U.S. population) are applied to the observed rates to risk-adjust the rates observed in the user's data. The risk-adjusted rates will then reflect the age and sex distribution of areas in the baseline file rather than the distribution for the areas covered by the users' data. This will allow risk-adjusted rates produced by various users to be compared directly to one another. The overall means and regression coefficients were derived from AHRQ's State Inpatient Databases (SID) for 19 states. The codes to generate these baseline means and coefficients are not part of the PQI module.

5. Create MSX smoothed rates.

Shrinkage factors are applied to the risk-adjusted rates for each PQI in a process called multivariate signal extraction (MSX). These shrinkage factors were calculated from the SID database of 19 states. For each PQI, the shrinkage estimate reflects a 'reliability adjustment' unique to each indicator. The less reliable the PQI over time and across areas, the more the estimate 'shrinks' the PQI toward the overall area mean. The resulting rate will appear "smoother" than the raw rate, meaning the year-to-year fluctuations in performance are likely to be reduced. More information on interpreting smoothed rates is contained in the interpretation section of this document. The shrinkage factors are provided as part of the PQI software and do not need to be calculated by users.

These five steps reflect the PQI module production in a nutshell. The next section of this document describes the specifics of each software component of the PQI module software.

Program descriptions

This section describes the three SPSS programs that assign, calculate, and print the Prevention Quality Indicators.

For each program there is a description, a list of input and output files, and an explanation of changes to the program that may be required. The flow of data through the PQI module programs is shown in the flowchart in Figure 1 of page 3.

If you desire to create and examine observed PQI rates, then the PQSPSA1.SPS and PQSPSA2.SPS programs will need to be used. If you also wish to create risk-adjusted and smoothed PQI rates, then you will also need to run the PQSPSA3.SPS program.

Program 1: PQSPSA1.SPS

The PQSPSA1.SPS program processes hospital discharge abstract data and flags inpatient records if they contain outcomes of interest. Outcome indicator names have prefix of "T" (Top). Stratifier variables are constructed at the beginning of the program.

This program assumes that the input data file (consisting of inpatient discharge abstract data) conforms to specific variable names, attributes, and coding conventions. See Table 4 on page 7 for variable names and attributes for the input data file.

Partial definitions of the Prevention Quality Indicators are given in Table 1 on page 4. This table is presented to assist those individuals who desire to examine the software source code statements. Complete definitions of the indicators are given in Appendix A of the *"Guide to the Prevention Quality Indicators".*

Input:

1. User supplied SPSS inpatient data set consisting of administrative hospital discharge abstract data. This data set is a discharge level file with an array of diagnosis and procedure codes, among other data elements.

Output:

1. SPSS data set (called PQA1.SAV) containing inpatient records with input variables, stratifiers, and flag indicators (TAPQxx) for the outcomes of interest that will later form the numerators for the PQI rates.

2. DESCRIPTIVES (with N, MIN, MAX, MEAN, and SUM) of all of the numeric variables in the output data file.

Changes:

Change the !LET parameters at the top of the program to specify the following:

1. !TEMPDIR should specify an existing directory where SPSS can save intermediate data sets temporarily. These data sets can be deleted once the program completes.

2. !PERMDIR should specify an existing directory where SPSS can save data sets with the final flags (PQA1.SAV). This is the directory where the program will look for the input data set with discharge records.

3. !TEXTDIR should specify the directory location where the AHRQ-supplied text files are stored.

4. !INDATA should specify the name of the input SPSS data set containing discharge records with procedures and diagnoses. This dataset must be located in the directory specified by !PERMDIR, above.

5. !MAXDX should specify the number of diagnosis variables in the input SPSS data set.

6. !MAXPR should specify the number of procedure variables in the input SPSS data set.

Program 2: PQSPSA2.SPS

The PQSPSA2.SPS program calculates the observed or raw rates for the area-level Prevention Quality Indicators, using the data (PQA1.SAV) derived in the previous step (PQSPSA1.SPS). These observed rates are stratified by combinations of area with sex, age, and race categories. The program first totals the indicator flags created by the previous program, and then for each of the desired stratifiers divides these totals by the pertinent residential population. The population denominators are stored in variables with names that have a prefix of "P" (Pop). The Observed rates are stored in variables that have a prefix of "O".

Input:

1. The SPSS dataset created in Program 1 (PQA1.SAV).

2. A text file with Census area residential populations, stratified by area, age, sex, and ethnicity categories. Three such files are currently provided along with the PQI module software. The files are QIPOP97.TXT, QIPOP98.TXT, and QIPOP99.TXT. The user should select the file for the year that best matches the user's discharge data set.

Output:

1. SPSS data set (PQA2.SAV) with summary records that contain observed rates (OAPQxx variables where xx refers to the indicator number), the counts of outcomes that formed the numerators of the rates (TAPQxx variables), and the residential population totals that formed the denominators of the observed rates (PAPQxx variables).

2. DESCRIPTIVES (N, MIN, MAX, MEAN, and SUM) of all of the numeric variables in the output data file.

Changes:

Change the !LET parameters at the top of the program to specify the following:

1. !TEMPDIR should specify an existing directory where SPSS can save intermediate data sets temporarily. These data sets can be deleted once the program completes.

2. !PERMDIR should specify an existing directory where SPSS will read the data set from Program 1 (PQA1.SAV) and save the data set from this program (PQQA2.SAV).

3. !TEXTDIR should specify the directory location where the AHRQ-supplied text files are stored.

4. !POPFILE should specify the name of the population file within the !TEXTDIR directory to be used in calculating the observed rates.

Program 3: PQSPSA3.SPS

The PQSPSA3.SPS program calculates age and sex risk-adjusted rates for each PQI (overall rates and rates by area), and then calculates smoothed rates.

Input:

1. SPSS data sets created by Programs 1 (PQA1.SAV) and 2 (PQA2.SAV).

2. A text file with Census area residential populations, stratified by area, sex, and discrete age categories. Three such files are currently provided along with the PQI module software. The files are QIPOP**A**97, QIPOP**A**98, and QIPO**A**P99. The user should select the file for the year that best matches the user's discharge datafile.

3. A text file (MEANSA97.TXT) containing overall means from the reference SID dataset for use in the risk adjustment process. This file is provided to you as part of the PQI module.

4. A text file (COVARA97.TXT) containing regression coefficients from a regression that was run on a reference SID dataset. These coefficients will be used in the risk adjustment process. This file is provided to you as part of the PQI module.

5. A text file (MSX97.TXT) containing variables to be read into a data set that will be used for smoothing the risk-adjusted rates.

Output:

1. SPSS data set (PQA3.SAV) containing the observed rates (OAPQxx variables), the risk-adjusted rates (RAPQxx variables), the smoothed rates (SAPQxx variables), the counts of outcomes that formed the numerators of the observed rates (TAPQxx variables), and the residential population totals that formed the denominators of the observed rates (PAPQxx variables).

2. DESCRIPTIVES (N, MIN, MAX, MEAN, and SUM) of all of the numeric variables in two intermediate work files and in the final output data file.

Changes:

Change the !LET parameters at the top of the program to specify the following:

1. !TEMPDIR should specify an existing directory where SPSS can save intermediate data sets temporarily. These data sets can be deleted once the program completes.

2. !PERMDIR should specify an existing directory where SPSS will read the data sets from Programs 1 (PQA1.SAV) and 2 (PQA2.SAV) and save the data set from this program (PQQA3.SAV).

3. !TEXTDIR should specify the directory location where the AHRQ-supplied text files are stored.

4. !COVARA should specify the name of the file (COVARA97.TXT) containing the regression coefficients to risk adjust the observed rates

5. !MEANSA should specify the name of the file (MEANSA97.TXT) containing the population means to risk adjust the observed rates.

6. !POPA should specify the file (e.g., QIPOPA97.TXT) containing population estimates to risk adjust the rates.

7. !MSX should specify the file (MSX97.TXT) containing the MSX shrinkage factors to smooth the adjusted rates.

Reviewing the printed output.

This section contains tips for reviewing some of the printed output from the PQI module. These tips are oriented toward explaining the interrelationships between printout items from different programs and hopefully will help to reveal the nature and structure of the module outputs. For guidance in interpreting the results, see the next section which begins on page 17.

PQSPSA1.SPS

The initial printout from the PQSPSA1.SPS program contains descriptive statistics for all of the numeric variables in the output discharge-level dataset. It will contain information for the newly constructed TAPQxx flag variables that will later form the numerators for the indicator rates. For each TAPQxx flag variable:

- The SUM will contain the total number of observations in the dataset that were found to have the particular outcome of interest.

- For the majority (14 of 16) of the indicators, the MEAN, MINIMUM, and MAXIMUM will usually be the value one since the flag variables have either been set to missing ('.') or to a value of one. The two exceptions to this are the two indicators (#2, for Perforated appendix, and #9, for Low birth weight) that will based on subsets of the hospitalized population rather than the area residential population (see Table 1 on page 4). For these two indicators, a value of zero was assigned to the TAPQxx flag if a particular observation was part of the population for the rate denominator but did not have the particular outcome of interest to be included in the rate numerator. So for example, TAPQ02 = 0 implies a patient who had an appendectomy performed, but did not have a perforated appendix.

- For the two hospital-based indicators (#2 and #9), the MEANs will contain a close approximation of the eventual overall observed indicator rates. The values will change slightly after PQSPSA2.SPS has applied additional parts of the indicator definitions.

- N lists the number of observations in the dataset with non-missing values. For the 14 area-based indicators, N for TAPQxx will be the same as the SUM. For the two hospital-based indicators, N will contain the denominator for the observed indicator rate.

PQSPSA2.SPS

The printout from the PQSPSA2.SPS program contains descriptive statistics for all of the numeric variables in the output summary dataset. It will contain information for the newly constructed OAPQxx rates, the PAPQxx denominators, and the TAPQxx numerators.

- The STRAT variable described in the first row of the table identifies the stratification level for the records in the output data set.

- The N statistic for STRAT contains the number of records in the output summary data set. A TAPQxx numerator variable with a lower value for N than STRAT indicates that there were no outcomes of interest in some of stratification cells. Similarly, a PAPQxx denominator variable with a lower value for N than STRAT indicates that for some stratification cells, the Census residential population estimate was zero.

- The MINIMUM value for the perforated appendix and the low birthweight TAPQxx numerators will be zero or higher since values of zero were assigned for observations that were part of the population for the rate denominator but did not have the particular outcome of interest to be included in the rate numerator. For the other 14 indicators, based on the residential area population, the MINIMUM value will be one or higher.

- In general, the MEANS and SUMs in this printout have no intuitive meaning because numbers are added up repetitively over the stratifiers.

PQSPSA3.SPS

The processing performed by this program is primarily at the area level. (Overall statistics for your dataset are also produced.) As a result, the PQSPSA3.SPS printed output is easier to interpret than the output from the preceding run when multiple stratifications may be in play.

There are three calls to descriptives in the program. The first two of these may be skipped over if you wish since the results are repeated in the third. They are included primarily as a troubleshooting device. The first table is generated immediately after the risk-adjusted rates have been calculated. The second is generated immediately after the smoothed rates have been calculated. The third is run on the permanent area-level output file.

- The N should contain the number of different areas (MSAs and counties) in your database.

- The MEANs, MINIMUMs, and MAXIMUMs have their normal meaning and provide comparisons among the different areas in your database. Note that the MAXIMUMs for the counter variables (the TAPQxx and PAPQxx variables) are associated with specific areas, and therefore these MAXIMUMs may not match those in the prior PQSPS2.SPS printouts since that run typically will include a record for the entire database.

- The SUMs of the counter variables (the TAPQxx and PAPQxx variables) yield the overall database totals.

Interpreting the results.

After performing all of the steps as previously outlined, users will have three estimates of performance for each PQI – observed, risk-adjusted, and MSX smoothed. This section will outline how these estimates can be used.

The Prevention Quality Indicators are not intended as definitive quality measures. But they are useful, low-cost measures that can potentially illuminate differences between providers and areas that may be addressable using quality improvement techniques.

Since there are no "right rates" established for most indicators, it is often best to compare area-level rates with other similar areas. These "peer groups" would ideally be as similar as possible in potentially important factors, such as socioeconomic status of the population, and urban or rural location.

Performance on a single PQI often cannot reliably indicate actual quality differences. For this reason, some indicators have been developed as measure sets. For instance, diabetes has four different ACSC indicators. Examining these indicators together is likely to produce a more complete picture of overall quality of care for this condition.

Observed means

Interpretation of the observed (raw) PQI rates may be complicated by concerns over noise and bias. However, the observed rates do not require complex statistical methods as do the risk-adjusted and MSX smoothed rates. For this reason, they are the most intuitive estimates of PQI performance. Observed rates can be used as a baseline measure when comparing to risk-adjusted and MSX smoothed rates, to determine the impact of risk adjustment/smoothing.

Risk-adjusted rates

Simply put, risk-adjusted rates are the estimated performance of areas on the PQIs if those areas had an 'average' casemix, as defined by age and sex. This average casemix is estimated and included in the software using estimates from 19 States in AHRQ's State Inpatient Databases (SID). Estimates of the average casemix do not reflect only the areas in the dataset being analyzed, but rather the distribution in age and sex among the areas in the SID data.

All area indicators are risk-adjusted using age and sex, except for low-birth weight, which is not risk-adjusted. Ideally, one might like to adjust for the underlying health status of each area, but population-based measures of health status by demographic groups are not readily available.

Users should compare risk-adjusted rates with the observed rates. This will indicate the impact of risk adjustment and presumably casemix on indicator performance. Providers with large changes in performance between observed and risk-adjusted rates presumably have a more or less complex case mix.

The construction of risk-adjusted rates in the PQI module follows the method described in Greene, Econometric Analysis (2nd Ed), 1993, Section 16.4.2 on calculating fixed effects in a linear model. Two important features of this approach should be noted. First, the risk-adjusted rates are coefficients on area level covariates ('fixed effects') in a linear model for each PQI that also accounts for patient demographics (age and sex). Generally, these coefficients reflect the relative performance on the PQI relative to a reference or 'omitted' group (e.g., males age 65-69). As a result, the risk-adjusted rates for each area would reflect performance on the PQI for the reference group only, making interpretation and comparison with the observed raw rates problematic. Rather, the approach incorporated into running the model is to first subtract the overall PQI mean for each covariate (e.g., age category 1, age category 2, etc.) prior to running the model. The benefit of this approach is that the risk-adjusted rates (the 'fixed effects' in the model) now reflect the estimated performance on the PQI for each area if that area had the 'average' casemix among all areas in the estimation sample.

Second, because the model is linear, rather than logistic, the estimated risk-adjusted rates may be negative (that is, the model does not require the rates to be between zero and one). This might happen, for example, if the observed rate is close to zero, and the area has a more severe than average casemix. The model would predict that the area's performance with an 'average' casemix would be less and subtract some adjusted amount from the observed rate. If that observed rate is already nearly zero, the adjusted rate may be negative. A negative rate means that the observed rate is close to zero, and that the area has a less-severe-than-average casemix. In order to facilitate the interpretation of the estimates, the PQI module imposes a lower bound of zero; i.e., negative values are set to zero.

MSX smoothed rates

The PQSPSA3.SPS program also yields the estimated MSX smoothed rates for each PQI. These smoothed rates are estimated using multivariate signal extraction (MSX). MSX is a Bayesian smoothing technique. Generally, indicators defined on relatively small populations or for relatively rare events are very noisy measures. In other words, many other factors other than quality can influence the observed rate. For factors that we can observe, such as the patient's age or gender, risk adjustment can account for their influence. There are many other clinical and non-clinical factors that we cannot observe. However, the MSX method estimates how much of an impact random differences in these factors have on the observed rate. The program accomplishes this by adjusting toward the overall area mean according to the degree of reliability of the specific provider or area indicator.

The MSX method estimates reliability by looking at area performance among multiple indicators and across multiple years for a single indicator. If areas that perform high in one year also tend to perform high in the next, and areas that are low in one indicator tend to perform low in other related indicators, then the methods incorporate this information in forming an estimate of how much of an area's performance on a single indicator in a single year is "signal" and how much is "noise". PQSPSA3.SPS reports the "signal" estimate, after removing the "noise".

These estimates are referred to as "smoothed" estimates because when the raw data is reported annually on a graph, for example, the line connecting the points may show massive fluctuations, seemingly with no apparent pattern. Some of these fluctuations are due to random differences in factors that influence performance, so once the impact of these factors is removed, fluctuations are reduced, or smoothed out. Improvements in performance will still be observed, however, they will only be observed when it is likely that these improvements are actually true differences, and not simply random variation.

The estimates of how related the Prevention Quality Indicators are among measures and over time for a typical area are based on estimates using the 19 states in the SID database. Therefore, PQSPSA3.SPS does not require multiple providers, measures, and years of data to operate. Instead shrinkage estimates were calculated from the combination of 19 statewide HCUP data sets to which the MSX had been applied. These shrinkage estimates are the best estimates of the impact that MSX smoothing would have on a particular PQI if MSX could be applied to the data set being analyzed. These shrinkage estimates are then applied to the adjusted rates for each PQI, giving 'smoothed' estimates of the rates.

The smoothed estimates represent the best guess of what the provider performance would be for any given PQI if the data contained only a minimal amount of noise. This has several implications. First, users can be more certain that changes observed over time represent true differences in performance, rather than random variation. Second, in any given year, users can be more certain that the rate does not reflect only random noise. This can best be seen by comparing the smoothed estimates with the observed raw rates, which will indicate the impact of MSX on that indicator. A large impact means that the observed rate of the indicator is less precise, meaning it contains more noise relative to other indicators sustaining less impact. Low precision can result from small numbers of observations, or for relatively rare events. Therefore, the impact of the MSX estimate will in general be greater for infrequent events. Plotting the MSX estimates over time will reflect more persistent performance from year-to-year, and the correlations among indicators will generally be stronger.

Comparing observed, risk-adjusted and smoothed rates

The purpose of the analysis determines which rates the user should look at in evaluating the performance of an area. If the user's primary interest is to focus on a particular area without any comparisons to other areas, simply examine the overall observed rate for the entire area, as well as further breakdowns by age, sex, and race/ethnicity which are the output created by the PQSPSA2.SPS program. Trend data are recommended for identifying changes over years.

If the purpose of the analysis is to compare the performance of a particular area with national, state, or regional averages or performances of other selected areas, then both observed and risk-adjusted rates should be examined. Variation in observed rates across areas is attributable to a variety of factors including differences in population demographics, disparity in access to and quality of care or other area characteristics ('systematic factors'), and random factors (non-systematic factors or 'noise'). Comparing observed and risk-adjusted rates can reveal if there is any difference between the area's population and the population of other areas. If the difference is minimal, one can compare the area's observed rate with the overall average across all areas. However, to account for differences in population demographics among different areas, risk-adjusted rates should be used for area-by-area comparisons.

After removing the impact of population demographics, if users want to examine potential existence of random factors, comparisons can be made between the risk-adjusted rates and the smoothed rates to determine if the differences in risk-adjusted rates across areas are due to systematic, as opposed to random, factors. The following two tables provide guidance on how to interpret differences in observed, risk-adjusted, and smoothed rates.

Comparing Observed Rates with Risk-adjusted Rates

Purpose: *To identify if there is any difference in the demographic composition of the area relative to the demographic composition of all areas combined*

Observed rate **>** Risk-adjusted rate	The area's population has a ***higher*** risk of being admitted to hospitals for the condition due to its demographic composition (for example, older or a greater proportion of a higher-risk gender).
Observed rate **<** Risk-adjusted rate	The area's population has a ***lower*** risk of being admitted to hospitals for the condition due to its demographic composition (for example, younger or a greater proportion of a lower-risk gender).
Observed rate **=** Risk-adjusted rate	The area's population is similar to other areas in demographic composition, suggesting that the demographic composition is not a contributing factor to the area's performance for the indicator.

Comparing Risk-adjusted Rates with Smoothed Rates (optional)

Purpose: *To determine if differences in risk-adjusted rates across areas are due to systematic or random factors after demographic composition is taken into account.*

Risk-adjusted rate ***similar to*** Smoothed rate	The area's risk-adjusted rate is more precise, an accurate reflection of the area's systematic ('true') rate. If there is any difference between the risk-adjusted rate and the overall area average[1], such difference is likely to be due to systematic factors.
Risk-adjusted rate ***different from*** Smoothed rate	The area's risk-adjusted rate is less precise[2]; that is, some of the difference between the risk-adjusted rate and the overall area average is due to random ('noise') factors. The smoothed rate is thus a more accurate estimate of the systematic rate than the risk-adjusted rate. Comparing the smoothed rate to the overall

	area average reveals more accurately the 'true' performance of the area.

Notes: 1. The overall area average refers to the weighted average risk-adjusted rates across all areas.
2. The risk-adjusted rates for areas with small population are generally less precise.

Benchmark timings

The benchmark runtimes given below are from runs made on a 500 MHz Pentium III, running Windows 98, with 256 MB of RAM, and an IDE hard drive. The dataset used contained 100,000 observations with 15 diagnosis fields and 15 procedure fields.

Step	Run time (in seconds)
1. PQSPSA1.SPS	050
2. PQSPSA2.SPS	029
3. PQSPSA3.SPS	220

User Support

We would like to receive your feedback on the AHRQ Quality Indicators.

Our Internet address for user feedback is: QI@ahrq.gov